The pressure (27.47 inches) observed on the British steamer *Jamaica Pioneer*, August 30, near Turks Island, ranks next lowest among the cases here reviewed. Examination of the detailed report in this instance also shows a very sharp vortex. The ship was only 7½ hours within the circle of pressures below 29.50 inches, and about an hour and 10 minutes while it was below 28.50 inches. The storm could not have been more than 2 days old at the time the *Jamaica Pioneer* crossed the center. This hurricane was moving quite rapidly at the time, and no clear eye was reported. Three days later the American steamer *Harvester* recorded 27.99 inches in this storm.

Readings below 28 inches in the other two storms, as reported by the Norwegian steamship *Tana* (Aug. 18), and the French ship *Washington* (Sept. 11), were also obtained at times when we must assume the cyclones to have been at a comparatively early stage of development. In neither of these storms can any center be definitely located or actual storm winds found in our reports more than 1 or 2 days prior to the date of the ship's encounter with the vortex.

The table carries five records taken at different times in the same storm, between September 11 and 17. It is of interest to note that these readings together constitute a consistent progression of dates, positions, and pressure values; this must be because the central pressure slowly increased as the storm progressed along its track.

In this connection, and bearing upon the question of the pressure distribution in tropical disturbances, reference is made to a report (not previously published in the REVIEW) obtained from the British steamer *Phemius*, which was involved for 4 days in intense hurricane conditions in the western Caribbean Sea in early November 1932. The meteorological log of this ship's experience, as given in detail in the British MARINE OBSERVER for October 1933 (vol. 8, pp. 123–125), indicates a hurricane of full maturity and of what appears to be unusual complexity of structure.

The lowest pressure observed on the *Phemius*, 27.01 inches (914.6 mb.), was reached on the 5th near 14° N. 79° W., and within a few hours after the vessel entered the hurricane area. This is one of the lowest barometer readings ever observed at sea level, and the lowest fully authenticated reading in the West Indian region so far as can be ascertained at this writing.

The fall in barometer as this vortex approached was very rapid, and was attended by hurricane winds so intense that superstructures on shipboard were badly damaged, and the ship's funnel actually torn out and blown overboard. The vessel was from that time disabled, and wallowed in the seas throughout the remainder of the storm.

The barometer did not rise with equal promptitude, however, and the height that prevailed a few hours before the vessel's encounter with this terrific vortex was not again reached for 4 days. Instead, there was a partial rise, followed by several marked decreases, to 28 inches on the third day and 27.92 on the fourth, as if there might have been either a family of subvortices or vacillation in the movement of the primary storm center. During those 4 days the ship was involved in continuous storm conditions of great severity, with the barometer for 3 days never rising above 28.50 inches.

This hurricane was the same that on November 9, 1932, advanced northward across Cuba and devastated the city of Santa Cruz del Sur, with the loss of several thousand lives. Its meteorological history in the western Caribbean has not been fully worked out, but the record of the *Phemius* very clearly shows an extent and complexity of structure that throws this case into great contrast with the simpler vortices reported in the ship's observations of 1933.

TROPICAL DISTURBANCES OF SEPTEMBER 1933

By C. L. MITCHELL

[Weather Bureau, Washington, October 1933]

Tropical disturbance of August 31–September 7.—This disturbance was central about 150 miles north of Puerto Rico the morning of the 1st. It evidently was attended by winds of hurricane force nearer its center at this time, inasmuch as the S.S. *Gulf Wing* reported a barometer reading of 28.98 inches and a wind velocity of 80 miles per hour about 150 miles east of Turks Island the evening of the 1st. The center passed some distance north of Turks Island during the night of the 1st-2d and over Harbour Island, about 2 miles northwest of the island of Eleuthera, Bahamas, the morning of the 3d. There was a calm of 30 minutes at this place. Previously the wind had reached an estimated velocity of 140 miles per hour. At 4 p.m. of the 3d, northwest storm warnings were ordered displayed at Miami, hurricane warnings north of Miami to Melbourne, Fla., and northeast storm warnings north of Melbourne to Jacksonville. At 10 p.m. storm warnings were displayed on the west Florida coast north of Key West to Cedar Keys.

The storm center apparently passed directly over Jupiter Inlet, Fla., where there was a lull of 40 minutes beginning near midnight of the 3d. The lowest barometer reading at Jupiter was 27.98 inches and the estimated maximum wind velocity 125 miles per hour. At West Palm Beach the lowest barometer reading was 28.77 inches with a maximum wind velocity close to 80 miles per hour. According to the official in charge at Miami, the only evidence of damage at West Palm Beach was the effects of high winds upon trees and shrubbery. However, a number of plate glass windows were broken and the damage in this respect would have been much greater except for the extensive protective measures taken. Between West Palm Beach and Jupiter, and extending northward to Fort Pierce, there was serious damage to electrical transmission lines and to telephone and telegraph wires, with many poles broken off or blown over. At Stuart there was serious damage from both wind and water. The most extensive damage in the entire storm area was at Olympia Beach, north of Jupiter Inlet, where there was widespread destruction of trees and shrubbery and serious damage to houses. The greatest loss was to the citrus crop in the Indian River section from Jupiter to Fort Pierce. In the vicinity of Stuart there are several groves that sustained a 100 percent loss of fruit and the uprooting of many trees. The estimated loss of citrus fruit for the State is 16 percent, or 4,000,000 boxes.

This storm recurved to the north during the afternoon of the 4th when its center was near the coast north of Tampa. Moving very slowly northward with diminishing intensity during the next 2 days it dissipated over Georgia on the 7th.

Tropical disturbance of September 10–21.—Although conditions were disturbed over and east of the Leeward Islands from the 7th to the 9th, it was not until the 10th

that a definite center could be located. This center was then about 300 miles northeast of the Island of St. Martin. By the morning of the 11th it was evident that the disturbance was one of considerable intensity, and it was so stated in the advisory issued at 10 a.m. of that date. This disturbance continued to move northwestward with gradually increasing intensity until the 15th, when it recurved and moved almost directly northward. Its center passed slightly west of Cape Hatteras about 8 a.m. of the 16th, after which it moved north-northeastward for about 12 hours, and then northeastward, reaching Nova Scotia the morning of the 18th, and extreme southern Iceland on the 21st.

Storm warnings were ordered at 4 p.m. of the 14th from Jacksonville, Fla., to Beaufort, N.C. At that time the disturbance had not begun to recurve and it was apparently headed for the northern South Carolina, or southern North Carolina, coast. At 10 p.m., storm warnings were extended northward along the coast to the Virginia Capes. The following morning the storm center was about 350 miles east of Savannah, Ga., and the indications were that it would reach the North Carolina coast not far from Cape Lookout in about 12 hours. Accordingly, hurricane warnings were ordered displayed at 10:30 a.m., from Wilmington to Cape Hatteras, and northeast storm warnings north of the Virginia Capes to Boston.

At 4 p.m. whole-gale warnings were displayed north of Hatteras to the Virginia Capes. At 8 p.m., the center was about 100 miles south of Cape Hatteras, moving almost directly northward, and the hurricane warnings at Wilmington were changed to northwest storm warnings at 9:30 p.m. At 10:30 a.m. of the 16th whole-gale warnings were ordered along the coast (but not at Baltimore and Philadelphia) north of the Virginia Capes to Atlantic City, and hurricane warnings were changed to storm warnings north of Wilmington to Hatteras. The 2 p.m. special reports indicated that the storm was beginning to recurve toward the northeast and that the center would pass some distance east of Cape Henry and the whole-gale warnings north of Hatteras to the Virginia Capes were changed to northwest storm warnings at 4 p.m. At 8 p.m. the storm was central about 125 miles south of Atlantic City, apparently moving northeastward. At 9:30 p.m., northeast storm warnings were extended north of Boston to Eastport, Maine, and whole-gale warnings on the coast north of the Virginia Capes to Atlantic City were changed to northwest storm warnings. The following morning when the storm center was about 150 miles east of Atlantic City, whole-gale warnings were ordered displayed from Provincetown to Nantucket, Mass.

The principal damage done by this storm was from a short distance south of New Bern, N.C., to the Virginia Capes. The following is quoted from a report by the official in charge, Wilmington, N.C., relative to a trip of inspection of the storm area:

* * * Very little damage was noted until a point a few miles southwest of New Bern was reached. Great damage was done by wind and high water in New Bern and vicinity; many telephone- and power-line poles blown down, numerous large trees uprooted or broken off, and houses and other buildings injured by falling trees and in some cases unroofed. At least one tree 4 feet in diameter in the heart of the city was uprooted. Water reached a height of 3 to 4 feet in some of the streets which is about 2 feet higher than the previous record which occurred in September 1913. Along the highway from New Bern toward Beaufort at least 100 trees 10 inches or more in diameter were blown down. In Morehead City and Beaufort damage was apparently slightly less than in New Bern, but old residents in Beaufort declare the storm was the worst they had ever experienced. It is estimated that the maximum velocity of the wind in the New Bern-Beaufort area was at least 125 miles per hour. Loss of life was due chiefly to high water in isolated localities north of Beaufort from which escape was difficult or impossible. According to the latest reports a total of 21 lives were lost. Property damage along the entire North Carolina coast will total, according to early estimates, more than $1,000,000.

At Cape Hatteras the lowest barometer reading was approximately 28.25 inches about 7 a.m. of the 16th. The highest wind velocity preceding the arrival of the center was 68 miles per hour from the east and the highest after the center passed, 76 miles per hour from the northwest (estimated because 1 cup of the anemometer was blown away).

The damage done by the storm at Norfolk and the other places in the Virginia Capes section was comparatively slight and was far less than that caused by the August 1933 storm. Much credit is given by the business interests and newspapers of Norfolk to the Weather Bureau for its timely and accurate warnings. There was ample time for complete preparation for the storm, thus holding losses to a minimum. The highest wind velocity in the Capes section was 68 miles per hour from the northeast at Cape Henry. Farther north along the Atlantic coast the highest velocities were 48 miles per hour at Atlantic City and 52 miles per hour at Block Island, R.I., and Nantucket, Mass. No great amount of damage was reported north of the Virginia Capes.

Tropical disturbance of September 10–15.—Weather conditions over the extreme western Caribbean Sea became disturbed on the 9th and a center was located between Tela and Belize the evening of the 10th. During the next 2 days the disturbance moved very slowly north by east toward Cozumel Island, with gradually increasing intensity; however, after the evening reports of the 12th were received, the direction of movement changed abruptly and the center moved inland over the Yucatan Peninsula north of Payo Obispo. The disturbance then moved west-northwestward across the Peninsula and the southwestern Gulf of Mexico during the next 48 hours, and there was a marked increase in intensity while the disturbance was passing over the Gulf. The center passed directly over Tampico, Mexico, the morning of the 15th. There was a period of calm between 8 a.m. and 10 a.m., and the lowest barometer reading reported was 28.34 inches. Much damage was done in Tampico and vicinity but details are not available.

Northeast storm warnings were ordered displayed at Brownsville, Tex., the evening of the 14th, at which time the indications were that the storm center would reach the coast nearly 100 miles north of Tampico and cause strong northeast winds, possibly reaching gale force at Brownsville. Upon receipt of the morning Tampico report of the 15th in the early afternoon, the warnings at Brownsville were lowered.

Tropical disturbance of September 16–24.—All island stations from St. Kitts to Bridgetown, Barbados, showed a 24-hour decrease in pressure of 0.06 to 0.10 inch the morning of the 14th, indicating the approach of a disturbed condition from the east, but no definite center could be found passing between any of the islands of the Windward and Leewards groups. On the 18th the barometer began to fall slowly at Kingston, Jamaica, and a heavy sea was reported at that place the evening of the 19th. At the same time three vessels about midway between Jamaica and the Isthmus of Panama reported gentle southwest winds and pressure a few hundredths below normal. However, it was not until the evening of the 20th that a center could be located, by which time the disturbance, though of very small diameter, had attained great intensity. The S.S. *President Pierce* in about

latitude 18°50′ N., longitude 83°20′ W., reported a barometer reading of 28.79 inches and a wind velocity of 80 miles per hour from the southwest. A later report received by mail from the S.S. *Virginia* which, at the same time, was close to the position of the *President Pierce* gives the following barometer readings: 6 p.m., 29.65 inches; 7 p.m., 29.49 inches; 8 p.m., 28.78 inches; 8:20 to 8:30 p.m. (in calm center, stars visible), 27.44 inches; 9 p.m., 28.64 inches; 10 p.m., 29.24 inches; 11 p.m., 29.40 inches; midnight, 29.70 inches.

This disturbance moved west by north passing inland over the Yucatan Peninsula with center about 40 miles south of Cozumel Island near midnight of the 21st and into the southwestern Gulf of Mexico north of Campeche the evening of the 22d. The center passed inland a short distance south of Tampico, Mexico, the evening of the 24th, attended by winds of hurricane force. The evening report of the 24th received from the S. S. *J. N. Danziger* was remarkable because of the fact that the vessel was at the time in the center of the storm and reported a wind velocity of only 2 miles per hour and a barometer reading of 28.40 inches. As in the case of the storm of the 15th, great damage was done at and near Tampico, but details are not available.

Tropical disturbance of September 27–October 4.—A minor disturbance apparently moved westward between the islands of St. Kitts and St. Martin on the 27th. It was of such small diameter and slight intensity that the center could not be located definitely every 12 hours. However, available data indicate that it moved westward, until the 29th, when it turned to the north and northeast, passing some distance west of Port au Prince, Haiti, the evening of the 29th and centered north of Puerto Plata, Santo Domingo, the morning of October 1. Still of minor intensity, the disturbance then moved northwestward and later north-northwestward until the 4th, after which it could not be located.

Tropical disturbance of September 28–30.—This was a very minor disturbance that apparently developed northwest of the Isthmus of Panama and moved northwestward. Its center passed near Cape Gracias the evening of the 28th, then traveled west-northwestward and passed inland south of Belize, British Honduras, the morning of the 30th.

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